1994 Updated National Airspace System Performance Assessment for Year 2005

Douglas Baart
Anny Cheung

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16. Abstract

This report documents the evaluation of the National Airspace System (NAS) performance for year 2005. The National Airspace System Performance Analysis Capability (NASPAC) Simulation Modeling System (SMS) was used to simulate the future air traffic control (ATC) system. Airport airfield and technological improvements expected to be completed by year 2005 were included in this analysis. Future air traffic demand was based on the 1993 Terminal Area Forecasts (TAF).

The study results indicate that most of the delay in the system for year 2005 is caused by airfield capacity limitations. Three-fourths of the delay is related to ground operations or ground manifestation of airspace congestion . About 45 percent of the total delay is attributed to adverse weather. Airports that have no future airfield improvements planned show the highest delay estimates.

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INTRODUCTION

The objective of this study is to address the future needs of the National Airspace System (NAS). Throughput, delay, and on-time performance metrics at major airports were analyzed for year 2005. Future system technological advances and airfield improvements, designed to increase airport and airspace capacity, were used.

This report presents an analysis of future system needs by simulating capacity-related improvements to the NAS. It identifies system impacts of congested airspace and airports based on technological advances and airfield improvements planned to be completed by year 2005. Throughput and delay were used to measure the performance of the future Air Traffic Control (ATC) system. On-time performance metrics at modeled airports were also used as a measure of system performance.

METHODOLOGY

The National Airspace System Performance Analysis Capability (NASPAC) was used to simulate the NAS for year 2005. Annualization techniques were employed. Airport capacity estimates were derived from the 1993 Aviation System Capacity Plan and technological advances expected to be completed and implemented in the NAS by year 2005. Traffic increases placed at all NASPAC-modeled airports were derived from the 1993 Terminal Area Forecasts (TAF).

New technologies and improved procedural changes included in the analysis were Center TRACON Automation System (CTAS), Dependent Converging Instrument Approaches (DCIA), Simultaneous Converging Instrument Approaches (SCIA), Precision Runway Monitor (PRM), and Airport Surface Traffic Automation (ASTA). These technologies were designed in increase system capacity.

NASPAC Simulation Modeling System (SMS) was used to simulate the future NAS. Six 1990 weather days were simulated and weighted to produce annual results. Future 2005 air traffic demand was generated at each of the 58 modeled airports using the 1993 TAF. See appendix A for airports and ID's.

Airport capacity estimates were derived from the 1993 Aviation System Capacity Plan Report. The plan outlined all proposed airport improvements intended to be completed by year 2005. New technologies designed to increase system capacity were also included in the analysis. These include CTAS, DCIA, SCIA, PRM, and ASTA.

RESULTS

Delay recorded for year 2005 measured 8.4 million hours for passenger delay and 2.9 million hours for operational delay. This accounts for 12.9 and 6.1 billion dollars in delay cost, respectively, with an average of 19.6 minutes of delay per aircraft.

Total system-wide delay for year 2005 amounted to 8.4 million hours for passenger delay and 2.9 million hours for operational delay. This accounts for 12.9 billion and 6.1 billion dollars in delay costs, respectively. Operational delay refers to delay that accumulates during the course of a flight due to capacity limitations of ATC resources. Passenger delay is the difference between the scheduled arrival time and simulated arrival time of a flight at an airport. This is the type of delay that accumulates at each airport assigned to the flight's itinerary. System-wide delay averages out to 19.6 minutes per aircraft for the future system, compared to 1993 levels of 17.6 minutes per aircraft.

The percent of all on-time operations calculated for each modeled airport revealed small values at BOS, EWR, LAX, LGA, ORD, SFO and SNA.

Those airports that have no planned airfield improvements also recorded the largest passenger delay estimates. These airports include: SFO, 255,000 hrs; LAS, 622,000 hrs; MIA, 194,000 hrs; SNA, 201,000 hrs; BOS, 198,000 hrs; DCA, 104,000 hrs; FLL, 114,000 hrs; LGA, 115,000 hrs; ORD, 258,000 hrs; PHX, 143,000 hrs; SAN, 111,000 hrs; and DFW, 368,000 hrs. The number of arrivals and departures is expected to exceed the capacity (engineering specifications) of these airports for a good portion of the day in year 2005.

As expected, those airports that have no planned airfield improvements to increase capacity show the largest annual delay. These airports include: SFO, 255,000 hrs; LAS, 622,000 hrs; MIA, 194,000 hrs; SNA, 201,000 hrs; BOS, 198,000 hrs; DCA, 104,000 hrs; FLL, 114,000 hrs; LGA, 115,000 hrs; ORD, 258,000 hrs; PHX, 143,000 hrs; SAN, 111,000 hrs; and DFW, 368,000 hrs.

The percent of all on-time operations was determined for each NASPAC airport. These values represent the percent of operations serviced that do not experience a delay in excess of 15 minutes. The results indicate that those airports with no planned airfield improvements show the lowest incidence of on-time performance for year 2005.

Forty-five percent of the total delay was attributed to adverse weather for year 2005.

Ground delay made up 76 percent of the total delay for the future system. Delay caused by adverse weather is composed of 60 percent ground delay and 40 percent airborne delay.

The analysis also shows that delay attributed to adverse weather makes up 45 percent of the total delay for year 2005. It was also noted that ground related delay contributed to 76 percent of the total delay, and weather-related delay is composed of 60 percent ground delay and 40 percent airborne delay.

1. INTRODUCTION.

A major effort from the Federal Aviation Administration (FAA) Research, Engineering and Development (RE&D) Office is under way to safely increase Air Traffic Control (ATC) system capacity. Current forecasts project serious delay in the absence of airport and airspace improvements designed to increase system capacity. The National Airspace System Performance Analysis Capability (NASPAC) Simulation Modeling System (SMS) was used to study the impact new airport configurations, advanced technologies, and improved ATC procedures have on system performance. NASPAC SMS was designed to provide system-wide assessment of any change to the ATC system in terms of throughput and delay. Evaluations of the National Airspace System (NAS) are based on future traffic growth and projected airport and airspace capacity parameters. The simulation is a macro model that traces individual aircraft through the NAS and records the ripple effect of delay as it propagates throughout the system. The model may be used as a strategic system planning tool by providing a quantitative assessment of improvements to airports or advances in technology designed to increase system capacity of the future ATC system.

2. METHODOLOGY.

A scenario was generated to simulate traffic flows as they are expected to exist in year 2005 with all of the airport improvements in place. A 1993 baseline scenario was also developed so that comparisons could be made with current operations in the NAS. Airport capacity estimates used in the 2005 scenario were based on airfield improvements that were outlined in the Aviation System Capacity Plan and advances in technology expected to be completed by year 2005. These technological improvements, designed to increase airport capacity, are summarized in section 4 of this report. In review of the proposed expenditures contained in the Aviation System Capacity Plan, 24 airports modeled by NASPAC were identified to receive funding for either new runways or runway extensions. Funding for these airport enhancements is derived from local, state, and federal agencies. Table 1 lists all of the airport improvements that were modeled. Three runs of the model were averaged for each scenario to account for statistical variations associated with one run. This analysis was based on the average of three stochastic runs.

The 1993 and 2005 scenarios include six days that reflect different weather conditions in the NAS, allowing annualization of findings.

Percent of on-time operations were determined for each airport. This information was incorporated into the study in order to provide an additional measure of system performance. These values refer to the percent of operations that were delayed in excess of 15 minutes, based on the total number of operations serviced.

The MITRE Corporation developed a method for computing annual results of NASPAC-based analysis. Six scenario days were selected as representative of varying levels of instrument meteorological conditions (IMC) and visual meteorological conditions (VMC) across the

TABLE 1. AIRPORT IMPROVEMENTS MODELED

ID	Type of Improvement	Specifics
ATL	New commuter runway	3,000ft south (5th parallel).
BWI	New parallel runway	10R/28L.
CLT	New parallel runway	18W/36W, assume independent IFR.
DEN	New Denver Airport	(DVX)
DFW	Two new runways	GA rwy 16/34, rwy 18/36.
DTW	Two new runways	9R/27L and 4/22.
FLL	Runway extension	9R/27L.
IAD	New runway	1W/19W.
IAH	Two new runways	8L/26R and 9L/27R.
IND	New runway	5R/23L.
MCO	New runway	17L/35R.
MEM	New runway	18L/36R.
MKE	New Runway and ext.	7L/25R and 1L/19R.
MSP	New runway	11/29W.
MSY	New runway	1L/19R.
PHL	New runway	8/26.
PHX	New runway	8S/26S (3rd parallel).
PIT	New runway	10S/28S.
SDF	Two new runways	17L/35R and 17R/35L (parallels).
SEA	New runway	16W/34W.
SLC	New runway	16W/34W.
STL	New runway	12L/30R, 4,300ft from parallel.
SYR	New parallel runway	10L/28R.
TPA	New parallel runway	18/36.

58 NASPAC airports. To compute the annual results, weighting factors for each scenario day were applied according to the frequency of occurrence of similar days that were observed in year 1990. Table 2 shows the weights applied to the six scenario days.

TABLE 2. WEIGHTING FACTORS FOR THE SIX WEATHER SCENARIOS

Percent(%) VMC	Scenario Day Chosen	Weighing Factor
95% - 100%	January 13, 1990	80.00
90% - 95%	September 27, 1990	127.50
85% - 90%	May 16, 1990	86.25
80% - 85%	March 10, 1990	23.75
70% - 80%	March 31, 1990	17.50
< 70%	December 22, 1990	30.00

In order to evaluate the affects that adverse weather has on delay, a scenario was developed to remove IMC from all of the modeled airports. This was accomplished by using all of the VMC airport capacity estimates throughout the simulation. Comparisons were made between the 2005 and 1993 scenarios, with and without IMC weather for both years.

As a means of determining where the majority of the delay was occurring, ground and airborne delays were summarized and presented on a system level and for individual airports. Ground delay consists of pushback delay at a gate, taxi delay to and from active runways, and arrival delay caused by occupied runways. Airborne delay is caused by airspace capacity limitations. Airborne delay accumulates when flights compete for arrivals and departures at ATC resources, such as flow control restrictions, arrival and departure fixes, and sectors.

3. NASPAC OVERVIEW.

The NASPAC SMS is a discrete event simulation model that tracks aircraft as they progress through the NAS and compete for ATC resources. Resources in the model include airports, sectors, flow control restrictions, and arrival and departure fixes. NASPAC evaluates system performance based on the demand placed on resources modeled in the NAS and records statistics at 50 of the nation's busiest airports and 8 associated airports. NASPAC simulates system-wide performance and provides a quantitative basis for decision making related to system improvements and management. The model supports strategic planning by identifying air traffic flow congestion problems and examining solutions.

NASPAC analyzes the interactions between many components of the airspace system and the system's reaction to projected demand and capacity changes. The model was designed to study nation-wide system performance rather than localized airport changes in detail, therefore, airports are modeled at an aggregate level. The model shows how improvements to a single airport can produce effects of delay that ripple through the NAS. Each aircraft itinerary consist of many flight legs that an aircraft will traverse during the course of a day. If an aircraft is late on any of its flight legs, successive flight legs may be affected. This is the way passenger delay accumulates in the model.

NASPAC records two different types of delay, passenger and operational. Passenger delay is the difference between the scheduled arrival time contained in the Official Airline Guide (OAG) and the actual arrival time as simulated by NASPAC. Operational delay is the amount of time that an aircraft spends waiting to use an ATC system resource.

Traffic profiles consist of scheduled and unscheduled demand for each modeled airport. Scheduled demand is derived from the OAG and is used as the baseline from which future growth is projected. Unscheduled demand is determined from daily and hourly distributions taken from

real world data (tower count). Projected traffic growth for future years is provided by the TAF.

Key output metrics recorded in the model include delay and throughput at airports, departure fixes, arrival fixes, restrictions, and sectors, system-wide and at all modeled airports. Operational delay consists of airborne and ground delay. Airborne operational delay is the delay that a flight experiences from takeoff through navigational aids, sectors, and static and dynamic flow control restrictions. Ground operational delay accumulates when an aircraft is ready to depart but has to wait for a runway to taxi on or takeoff from, or when airfield capacity limitations prohibit the aircraft from landing. Operational delay contributes to passenger delay and is assigned to the airport to which the flight is destined. Sector entry delay occurs when the instantaneous aircraft count or hourly aircraft count parameters for that sector are exceeded. Monetary assessments are derived by translating delay into measures of cost to the user by using the Cost of Delay Module. The Cost of Delay Module was incorporated into version 3.1 of the NASPAC SMS.

The Cost of Delay Module was used to translate delay into cost metrics in order to determine cost to the airlines and economy. Form 41 for the last quarter of 1993, acquired from the Office of Airline Statistics (APO-200), was used to calculate operational and passenger delay cost. Operational costs include crew salaries, maintenance, fuel, equipment, depreciation, and amortization, and are reported by the airlines on a quarterly basis to the Department of Transportation Office of Aviation Statistics on Form 41. The data are disseminated into airborne and ground delay costs by carrier and aircraft type. Passenger costs are derived from the expected number of passengers on a flight times the FAA-endorsed value of $40.50, times the delay. The Origin and Destination Survey (O&DS Form 41) was used to estimate aircraft occupancy values.

4. ASSUMPTIONS AND CAVEATS.

All of the airport capacity estimates used in the analysis for year 2005 were based on airport airfield improvements projected in the Aviation System Capacity Plan and new technologies expected to be implemented by year 2005. The 1993 TAF were used to project traffic growth for year 2005. These forecasts depend on many factors which are subject to change, such as economic, and technological. The annualization method used in the 2005 scenario is an approximation and is based on weather observations taken from the year 1990. The model does not include re-routing or other methods used to minimize the impacts of adverse weather.

New technologies likely to be in place by year 2005 are designed to increase airport capacity without adding or extending new runways. The following is a list of future improvements that were modeled:

a. Precision Runway Monitor (PRM):

This would allow simultaneous parallel Instrument Flight Rule (IFR) arrivals on runways spaced between 3,000 and 4,300 feet.

ATL, CLT, MSP, RDU, CLE, JFK, and PHL are likely to be equipped with PRM by year 2005.

b. Final Monitor Aid (FMA):

Improved resolution would allow simultaneous parallel IFR approaches on dual runways spaced between 4,000 and 4,300 feet, without full PRM. Those airports that would take advantage of this technology are FLL and DEN.

c. Airport Surface Traffic Automation (ASTA):

This technology is designed to optimize surface operations through improved sequencing of departures and more tactical management of aircraft movement. All NASPAC-modeled airports were affected by this improvement.

In addition to improvements in technology, procedural changes for the future system have been considered for this study. These procedural changes designed to increase airport capacity are:

a. Center-TRACON Automation System (CTAS):

NAS-wide implementation of this system would optimize final approach separations by more efficiently distributing en route delay.

b. Dependent Converging Instrument Approaches (DCIA):

The reduction of terminal separation minima may be realized by monitoring aircraft approaching converging runways more accurately. Those airports affected include BOS, CLE, CLT, CVG, MEM, MKE, PHL, SFO, and STL.

c. Reduced Diagonal Separation for Parallel Approaches:

The reduction of diagonal separation from 2 nautical miles (nmi) to 1.5 nmi may be realized for parallel runways not eligible for independent parallel approaches and that are at least 2,500 feet apart. Affected airports include DAL, PHX, PHL, SLC, SJC, SEA, MSP, STL, and DEN.

5. RESULTS.

5.1 SYSTEM-WIDE.

For year 2005, the number of flights in the NAS is projected to increase by 4.8 million (22 percent), causing an increase of 3.7 million hours (47 percent) of delay. This translates into 19 billion dollars (50 percent increase) in delay cost. This projection is based on the 1993 TAF data, as well as airport improvements outlined in the Aviation System Capacity Report and advances in technology designed to increase system capacity.

Ground delay, which is made up of pushback delay, taxi procedures from active runways, and delay that is caused by occupied runways for a arriving flights, contributes about the same percentage of delay for the current, as for the future systems. This represents 77 percent of the delay produced from ground operations for the year 1993 and 76 percent for the year 2005.

Weather-related delay accounts for about 51 percent for the year 1993 and about 45 percent for the year 2005. Ground delay that is caused by adverse weather accounts for 60 percent of the total delay.

Table 3 compares system-wide delay and delay cost for years 1993 and 2005, as follows:

TABLE 3. ANNUAL DELAY AND COST OF DELAY FOR 1993 AND 2005.

	Year 1993	Year 2005
Number of Flights	21.4 million	26.2 million
Avg Delay/Aircraft	17.6 minutes	19.6 minutes
Total Delay	7.6 million hours	11.3 million hours
Cost of Delay	12.7 billion dollars	19.0 billion dollars

5.2 AIRPORT LEVEL.

BOS, DCA, DFW, FLL, LAX, LGA, MIA, ORD, PHX, SAN, SFO, and SNA showed significant increases in passenger delay for year 2005. Of this list, according to the Aviation System Capacity Report, only DFW and PHX are expected to add runways to increase airport capacity. Although DFW and PHX show high levels of passenger delay, operational delay observed at these airports are relatively small. This would indicate that the passenger delay is accumulating at other airports that serve these two airports and not a result of limited airfield capacity. Table 4 displays the increase in annual operations and delay for each of these airports. Figure 1 shows the projected demand at these airports plus additional airports with no planned airfield improvements. Figures 2 and 3 illustrate passenger and operational delay for these airports in the years 1993 and 2005. Passenger and operational delay cost is shown in figures 4 and 5, respectively.

On-time performance metrics indicate that less than 50 percent of the operations that are serviced at SFO and SNA are undelayed. LGA shows a 52 percent, LAX, a 57 percent, and BOS and EWR both show a 79 percent on-time performance estimate. All other NASPAC airports recorded relatively high on-time performance metrics for the year 2005. As expected, low on-time performance metrics were recorded at airports which also show high levels of operational delay. These measures are summarized for all NASPAC airports in figure 6.

TABLE 4. AIRPORTS WITH LARGEST DELAY ESTIMATES PROJECTED FOR YEAR 2005.

	OPS	PASS DEL	OPS DEL	PASS COST	OPS COST
BOS	661	198,000	143,000	340,000	176,000
DCA	385	104,000	19,000	227,000	19,000
DFW	1134	368,000	14,000	629,000	11,000
FLL	313	114,000	3,000	135,000	2,000
LAX	981	622,000	415,000	1,269,000	991,000
LGA	463	115,000	99,000	230,000	125,000
MIA	590	194,000	7,000	272,000	9,000
ORD	917	258,000	99,000	522,000	157,000
PHX	577	143,000	5,000	391,000	7,000
SAN	345	111,000	10,000	226,000	14,000
SFO	728	255,000	190,000	555,000	289,000
SNA	736	201,000	209,000	302,000	245,000

OPS - Number of Operations (x1000)
PASS DEL - Passenger Delay (hrs)
OPS DEL - Operational Delay (hrs)
PASS COST - Passenger Cost ($1,000)
OPS COST - Operational Cost ($1,000)

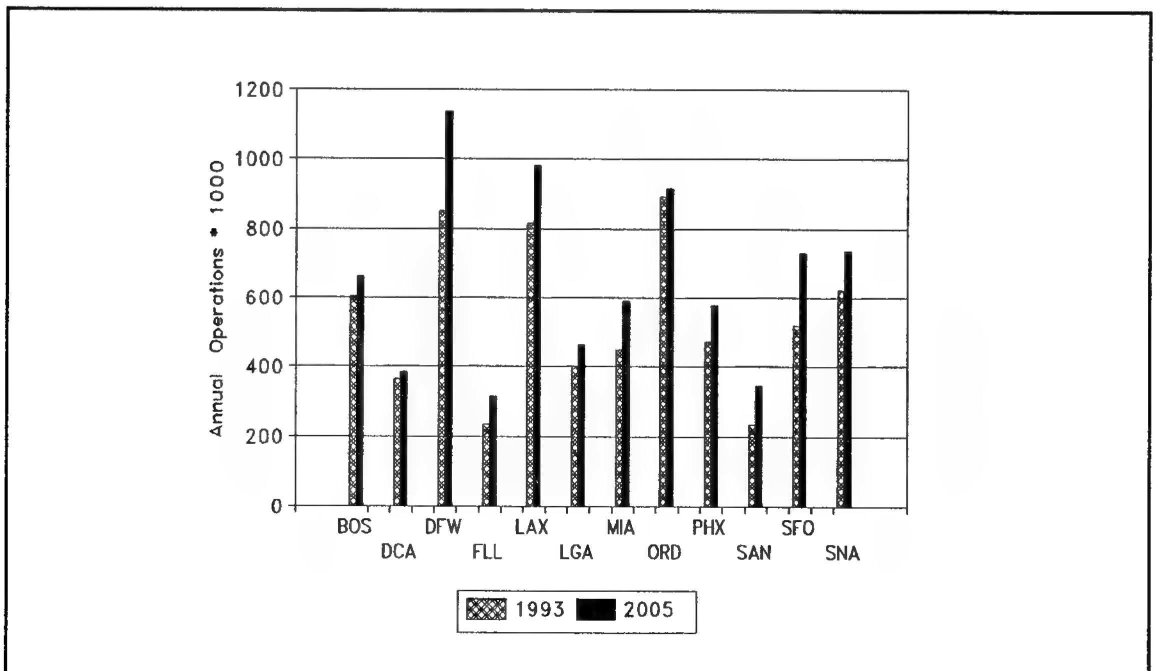

FIGURE 1. ANNUAL OPERATIONS

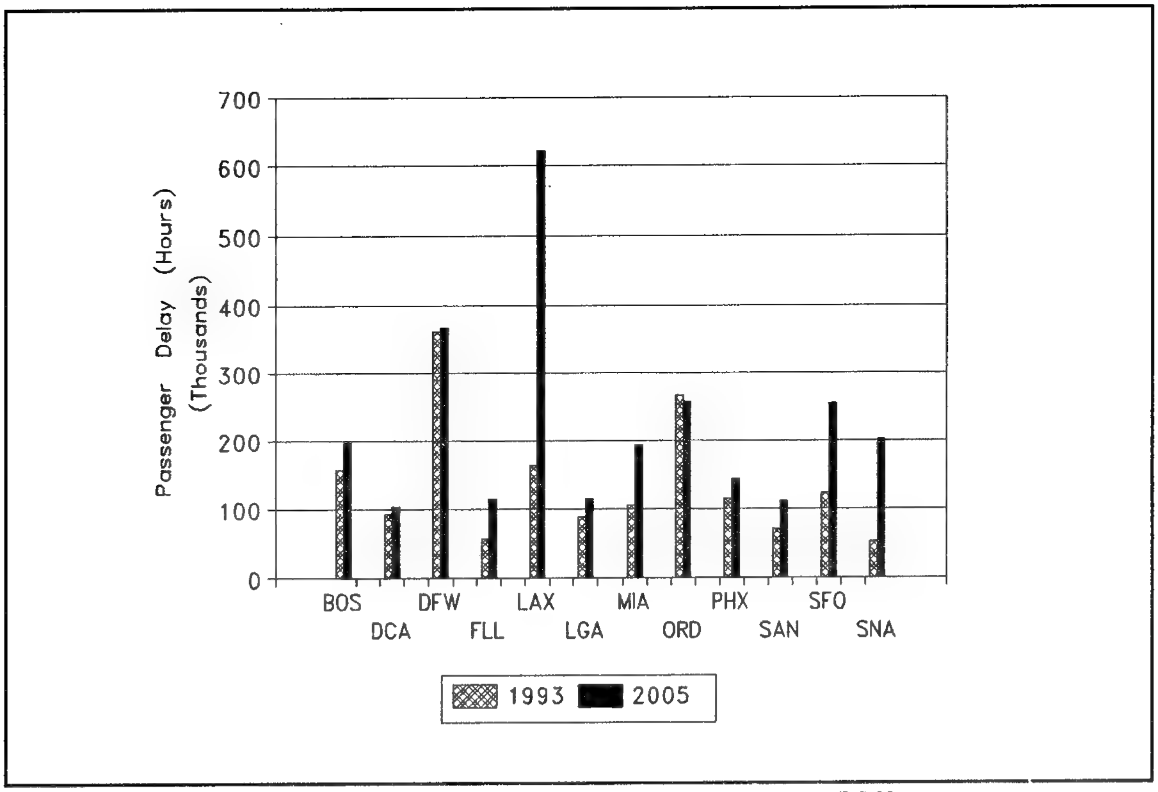

FIGURE 2. ANNUAL PASSENGER DELAY

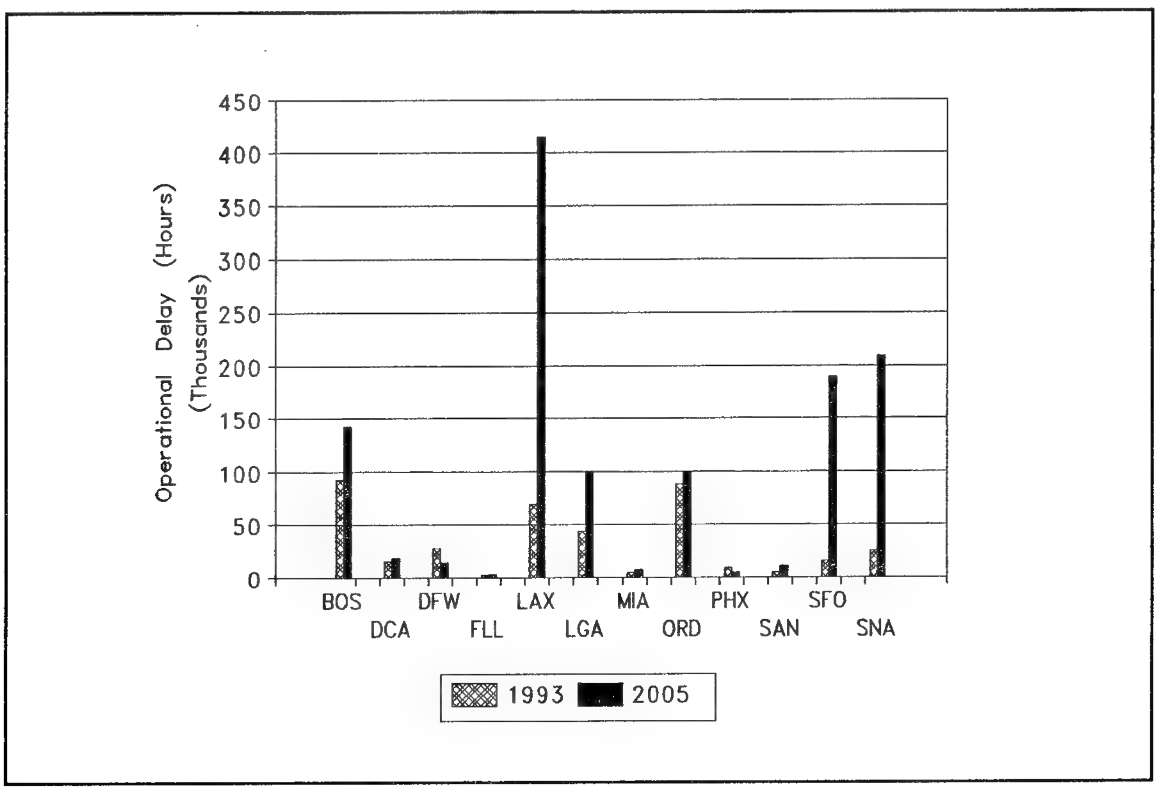

FIGURE 3. ANNUAL OPERATIONAL DELAY

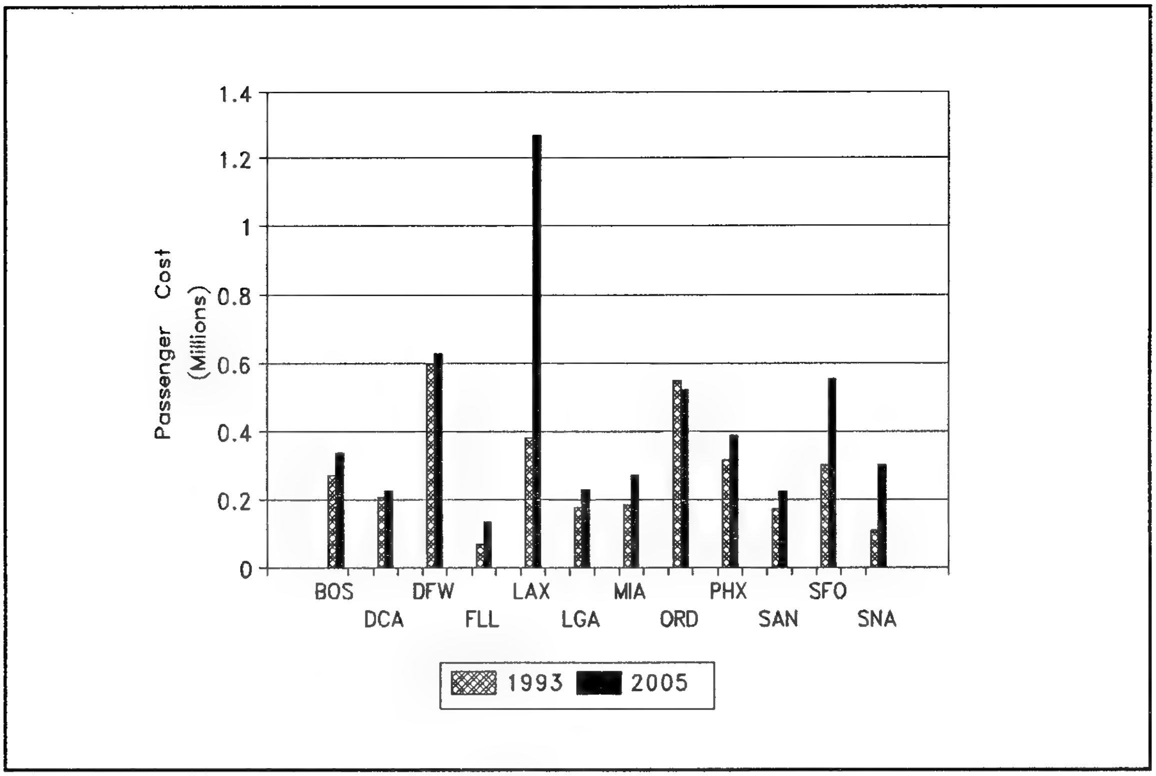

FIGURE 4. ANNUAL PASSENGER COST

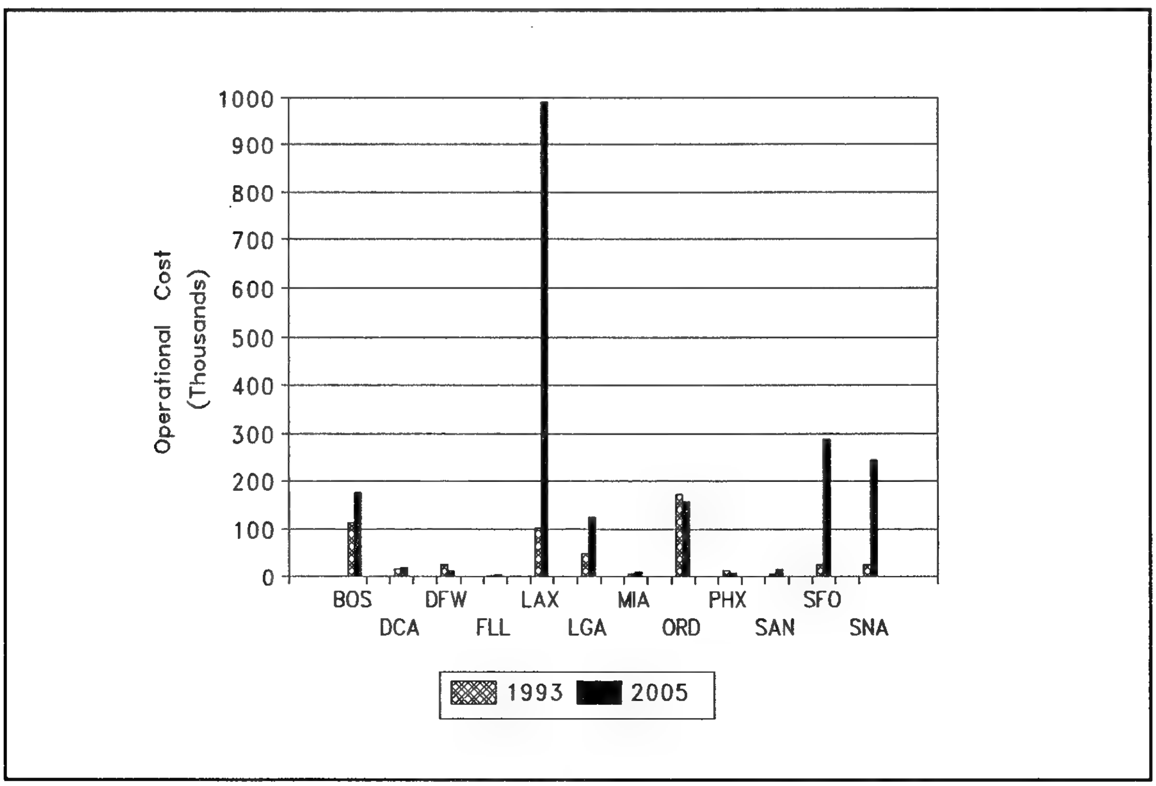

FIGURE 5. ANNUAL OPERATIONAL COST

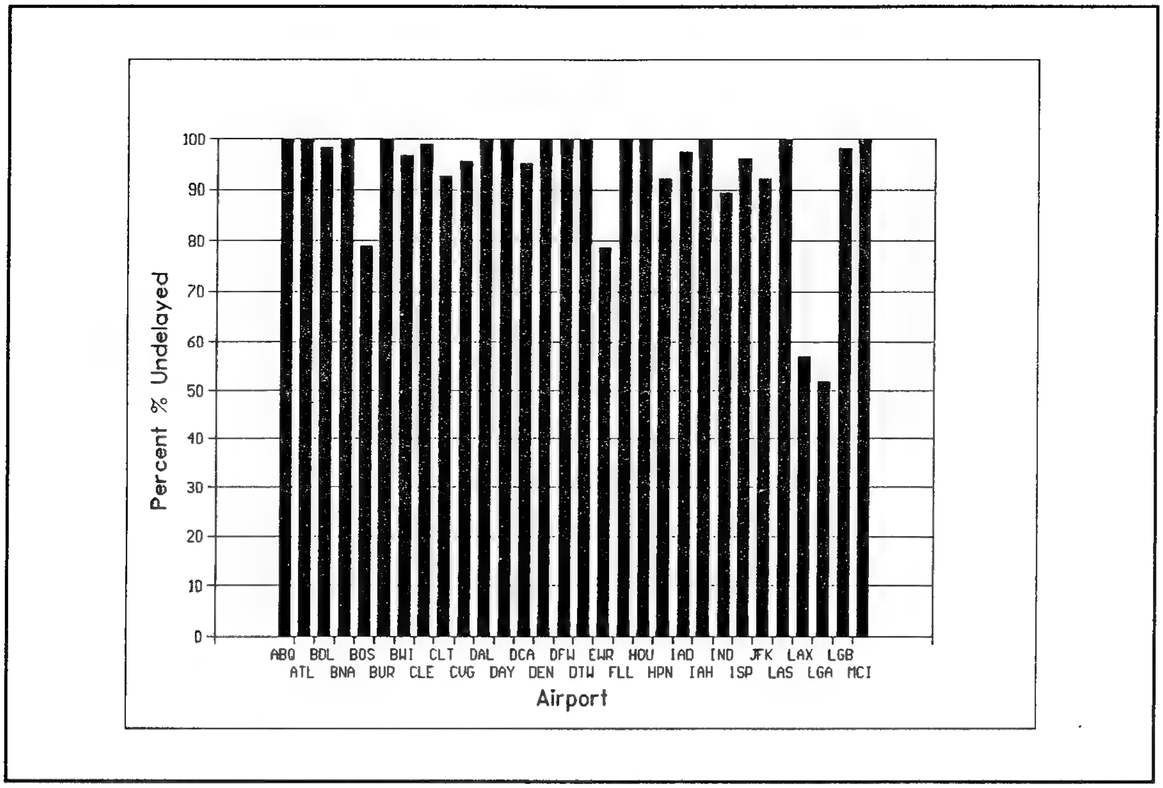

FIGURE 6. PERCENTAGE OF ON-TIME OPERATIONS FOR MODELED AIRPORTS YEAR 2005 (1 OF 2)

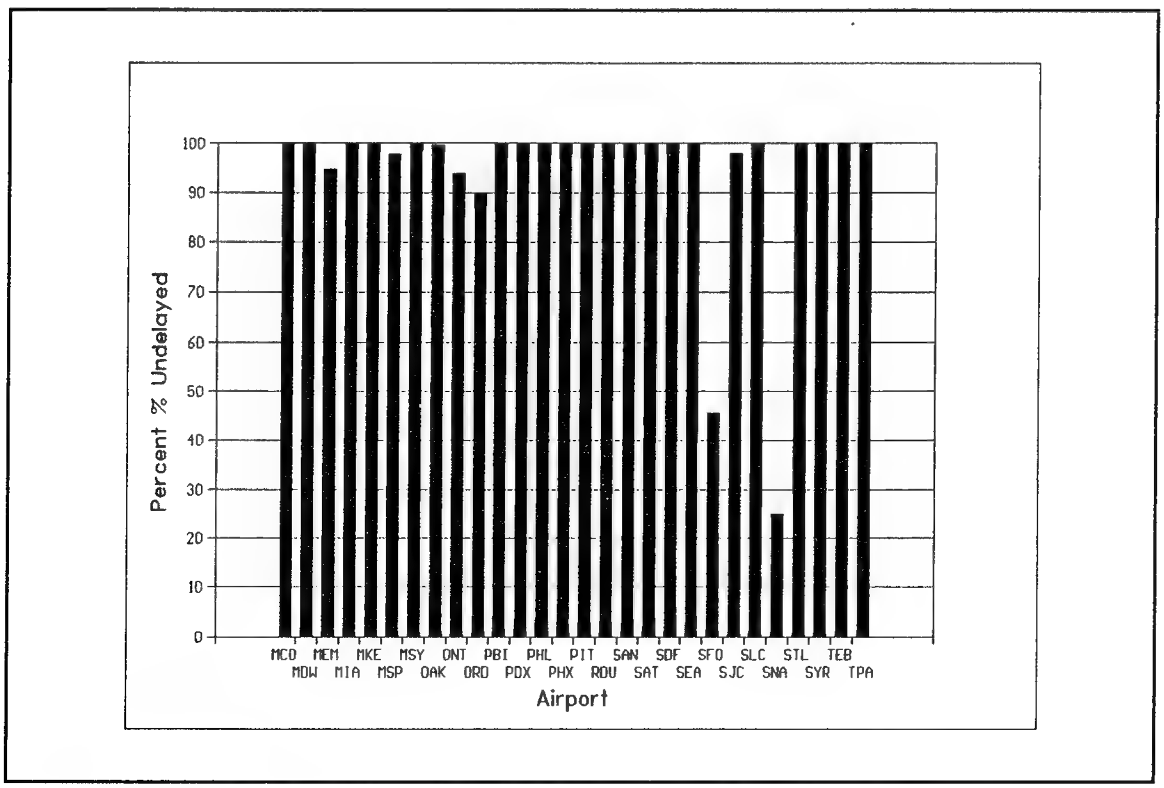

FIGURE 6. PERCENTAGE OF ON-TIME OPERATIONS FOR MODELED AIRPORTS YEAR 2005 (2 OF 2)

Daily capacity and demand profiles are displayed for those airports which record high delay estimates. These airports include BOS, DCA, DFW, LAX, LGA, ORD, SFO, and SNA. As indicated by figures 7 through 13, the number of daily arrivals exceeds the maximum arrival capacity (engineering specifications) for these airports during a large portion of the day. The line connected by solid triangles displays an arrival priority maximum value that could be achieved under VMC conditions. The line connected by the empty filled rectangles represents a departure priority maximum value that could be achieved under VMC conditions.

Measures of on time performance for passenger delay at each of the modeled airports are summarized in figure 14 by the percentage of on-time operations. Delay in excess of 15 minutes were used in the analysis.

The percentage of delay accumulated on the ground is depicted in figures 15 and 16. As shown, ground delay in years 1993 and 2005 make up a majority of the delay for most of the NASPAC airports.

Delay attributed to adverse weather is shown in figure 17 for all of the modeled airports for year 2005. As indicated by the bar chart, certain airports show greater weather-related delay. These include BOS, CLT, EWR, FLL, MIA, ORD, SFO, SNA.

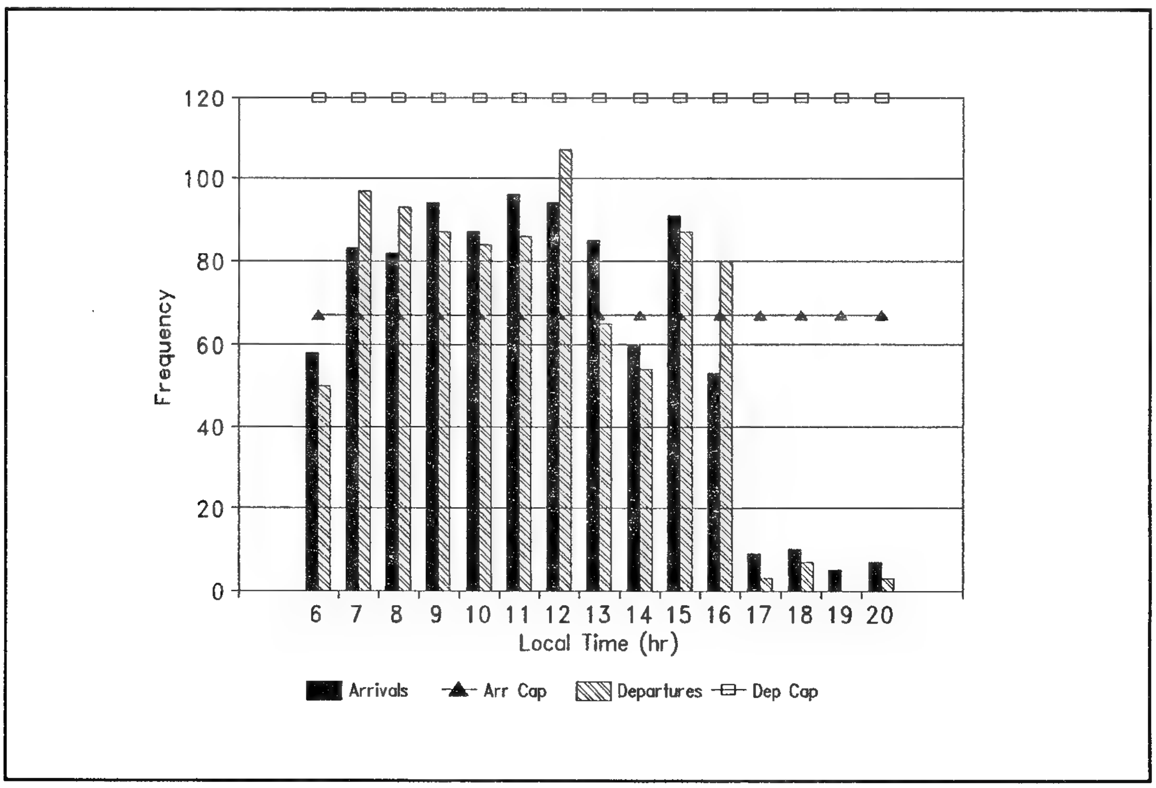

FIGURE 7. DAILY OPERATIONS BOSTON (BOS)

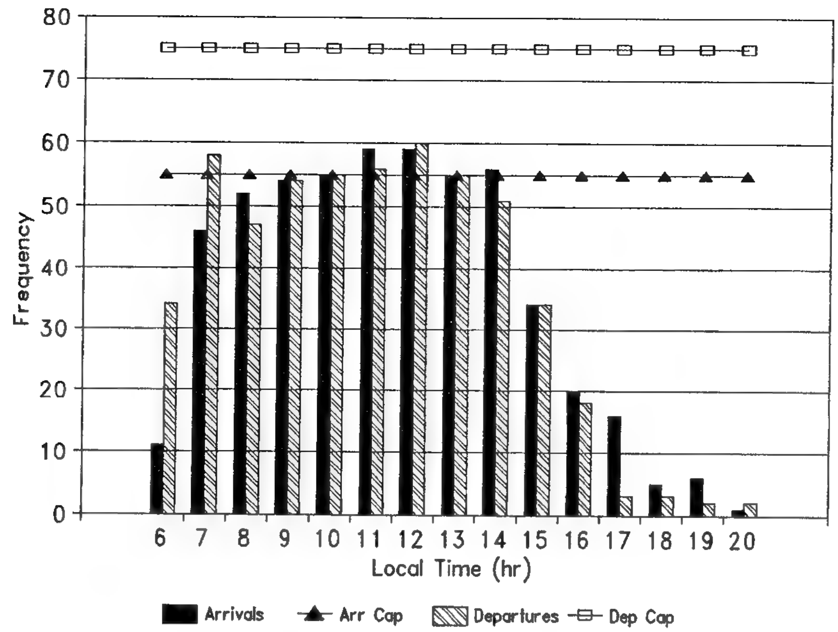

FIGURE 8. DAILY OPERATIONS NATIONAL (DCA)

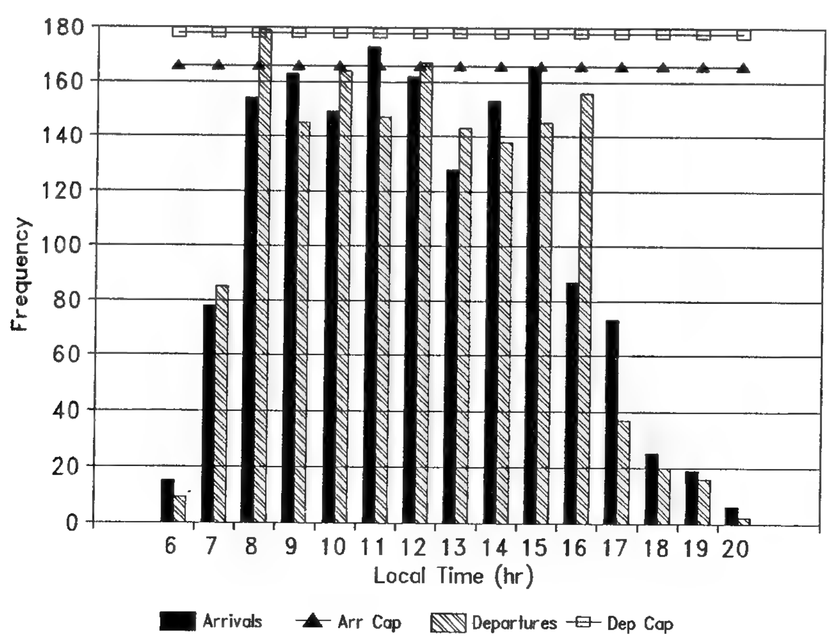

FIGURE 9. DAILY OPERATIONS DALLAS (DFW)

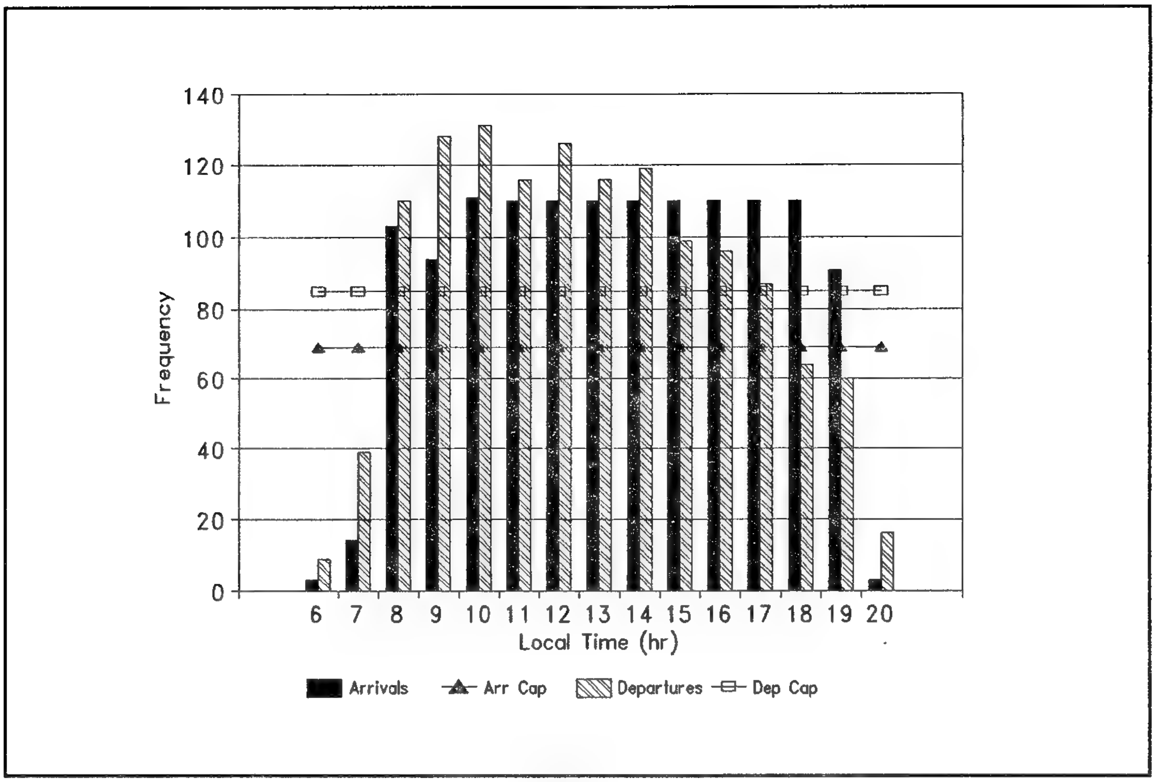

FIGURE 10. DAILY OPERATIONS LOS ANGELES (LAX)

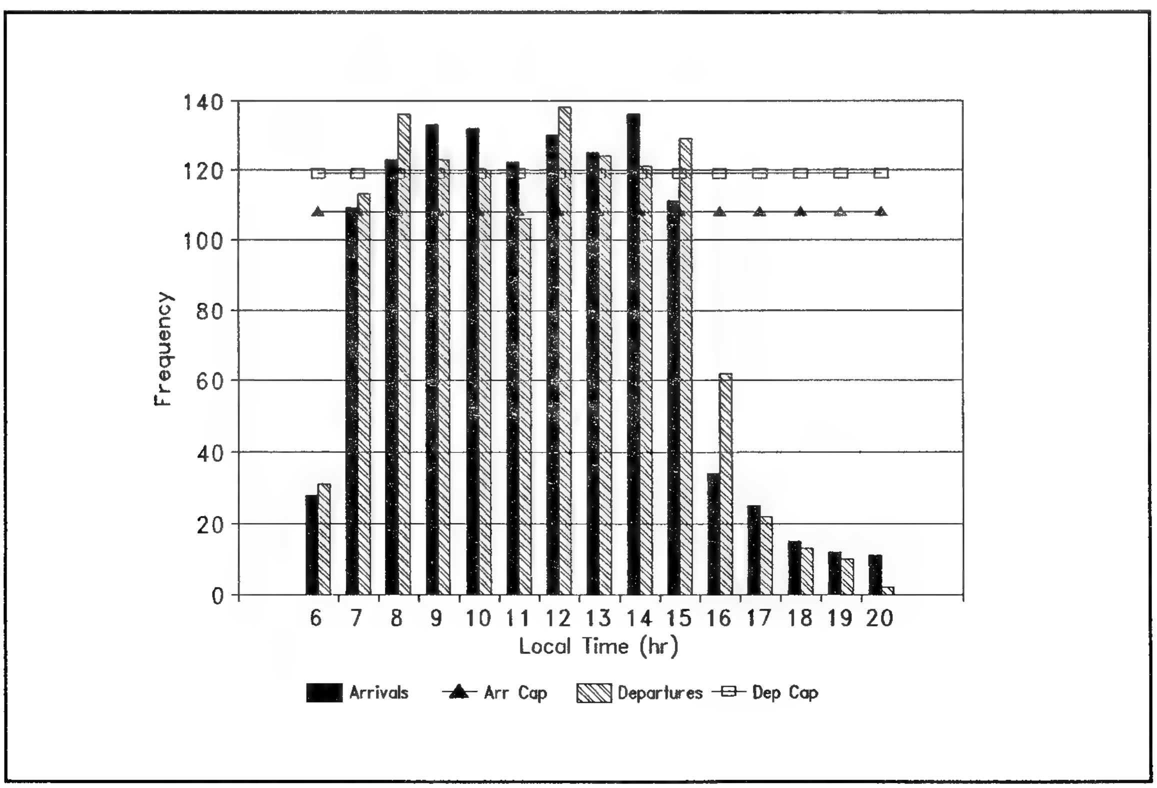

FIGURE 11. DAILY OPERATIONS O'HARE (ORD)

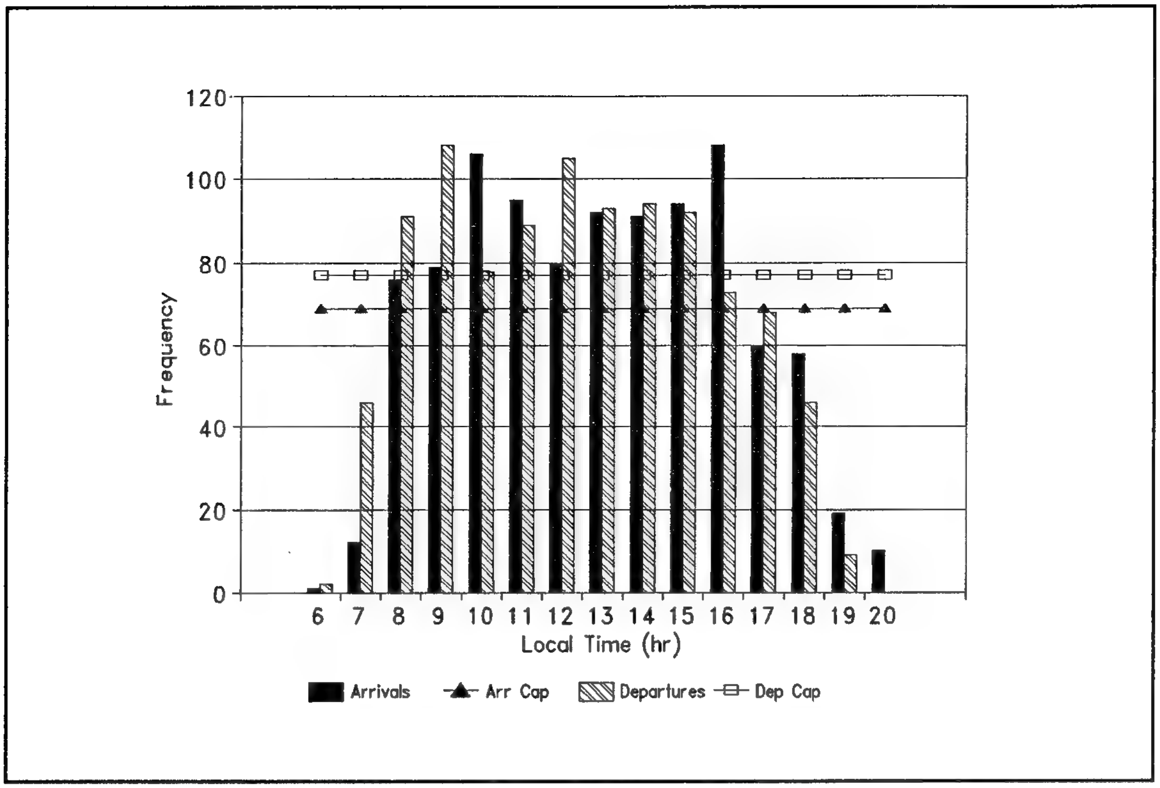

FIGURE 12. DAILY OPERATIONS SAN FRANCISCO (SFO)

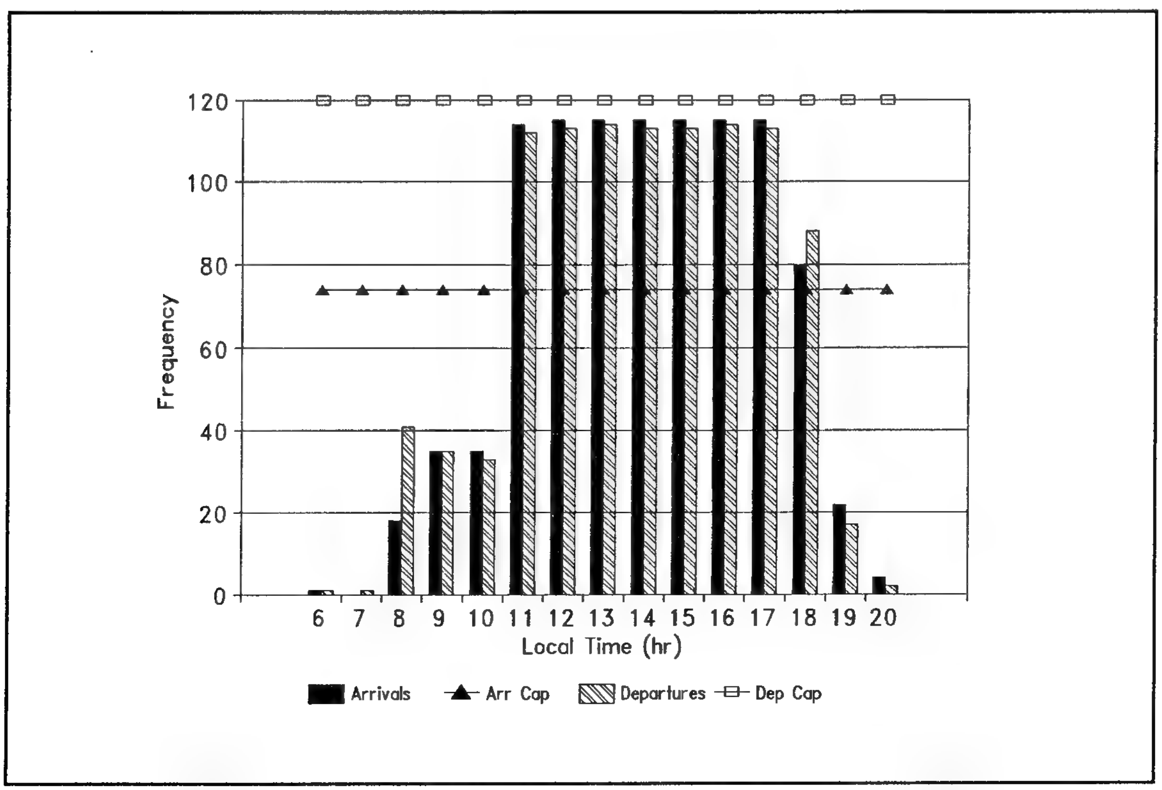

FIGURE 13. DAILY OPERATIONS SANTA ANA (SNA)

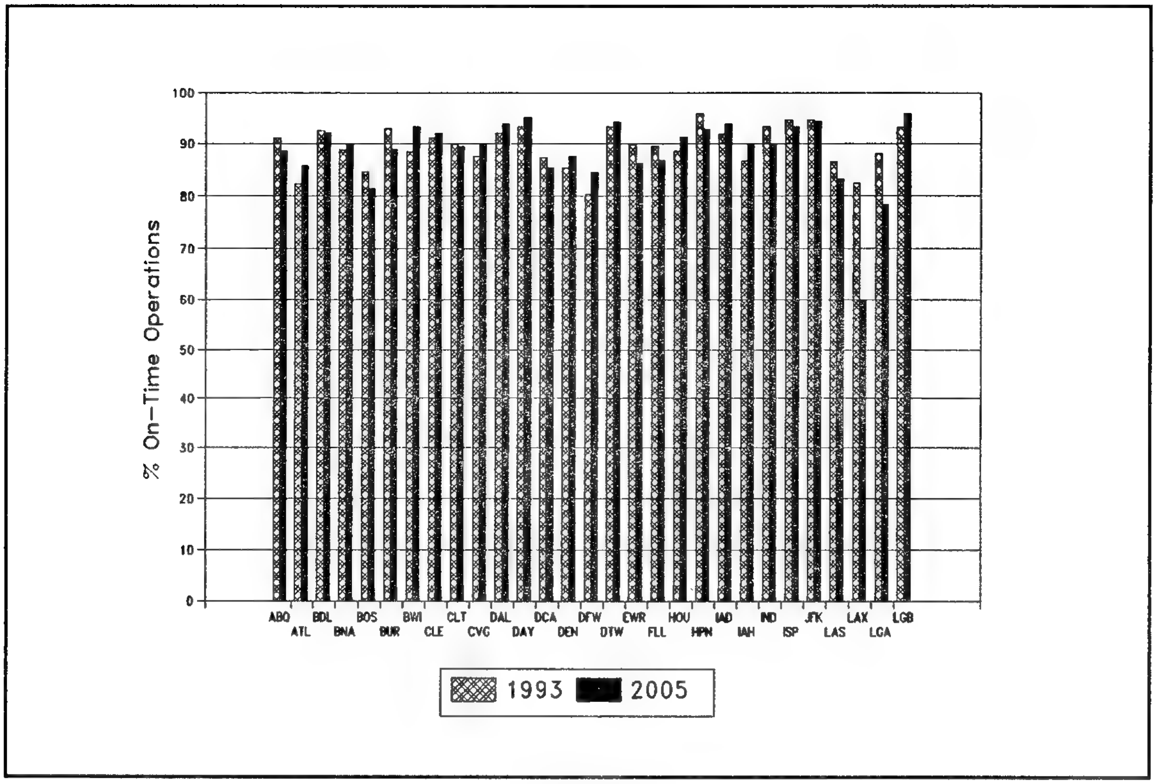

FIGURE 14. OPERATIONS WITH PASSENGER DELAY UNDER 15 MINUTES (1 OF 2)

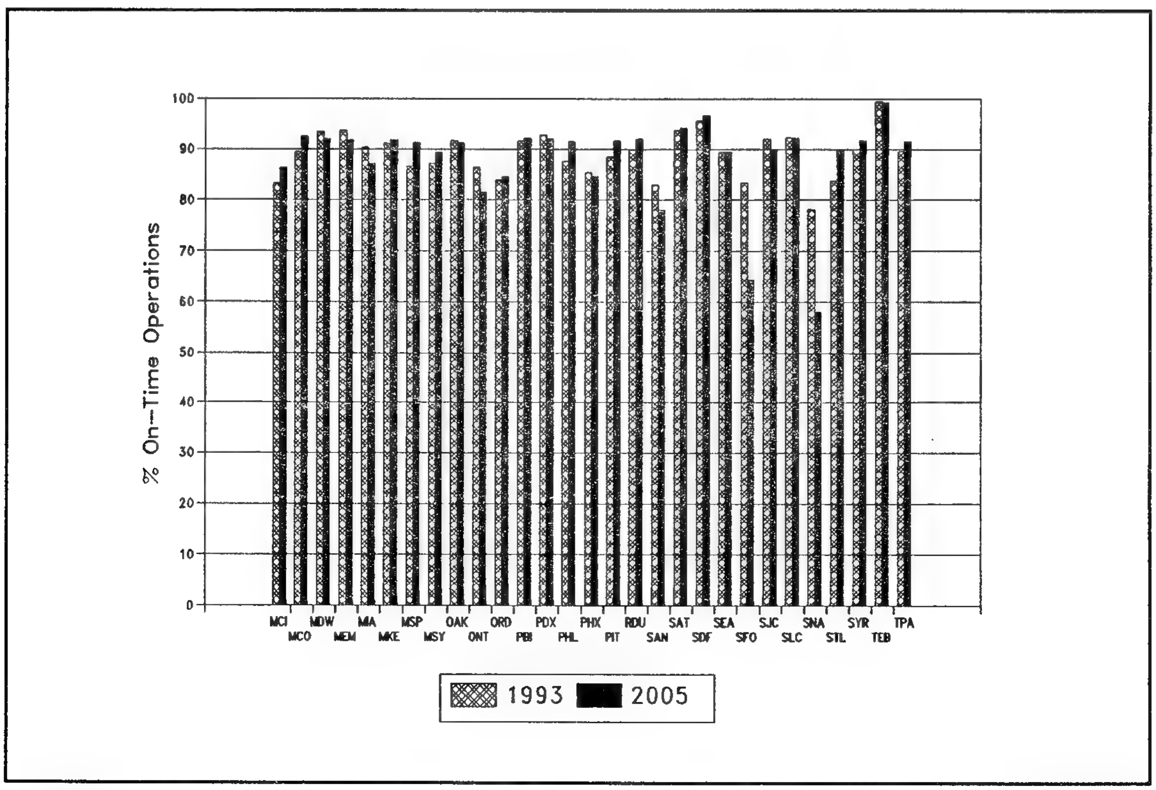

FIGURE 14. OPERATIONS WITH PASSENGER DELAY UNDER 15 MINUTES (2 OF 2)

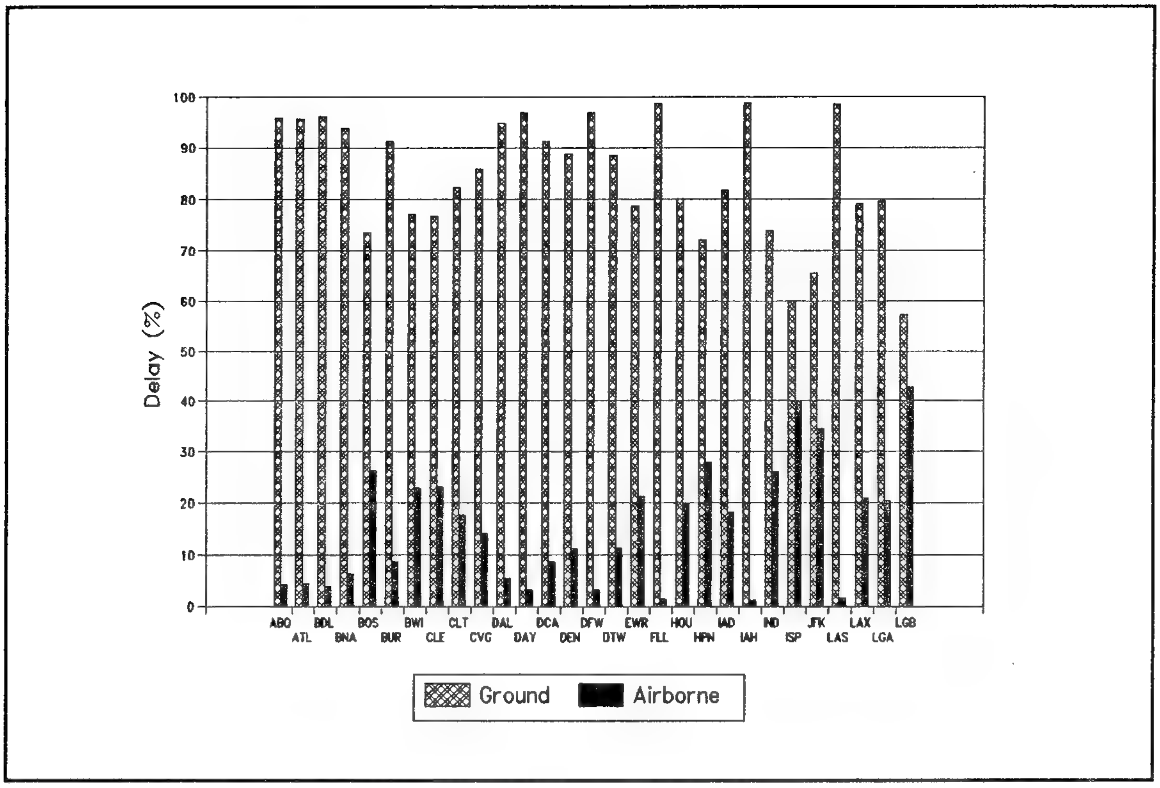

FIGURE 15. GROUND DELAY VS AIRBORNE DELAY YEAR 1993
(1 OF 2)

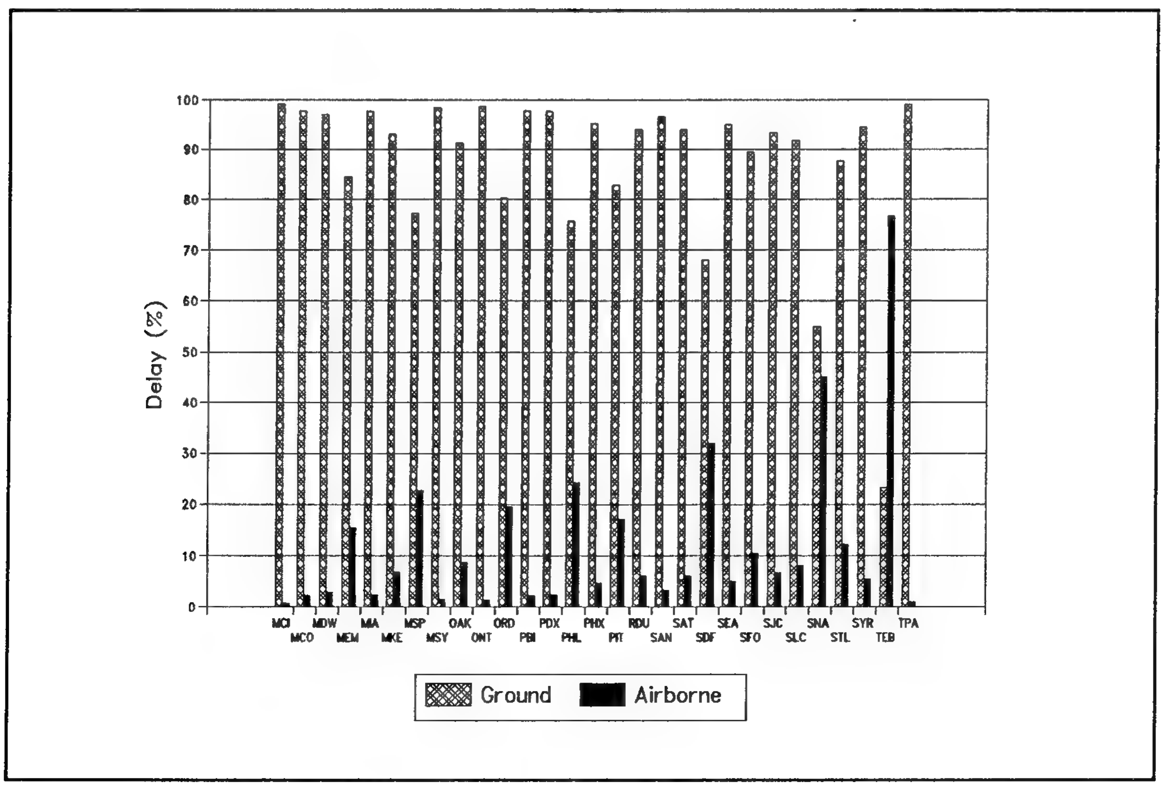

FIGURE 15. GROUND DELAY VS AIRBORNE DELAY YEAR 1993
(2 OF 2)

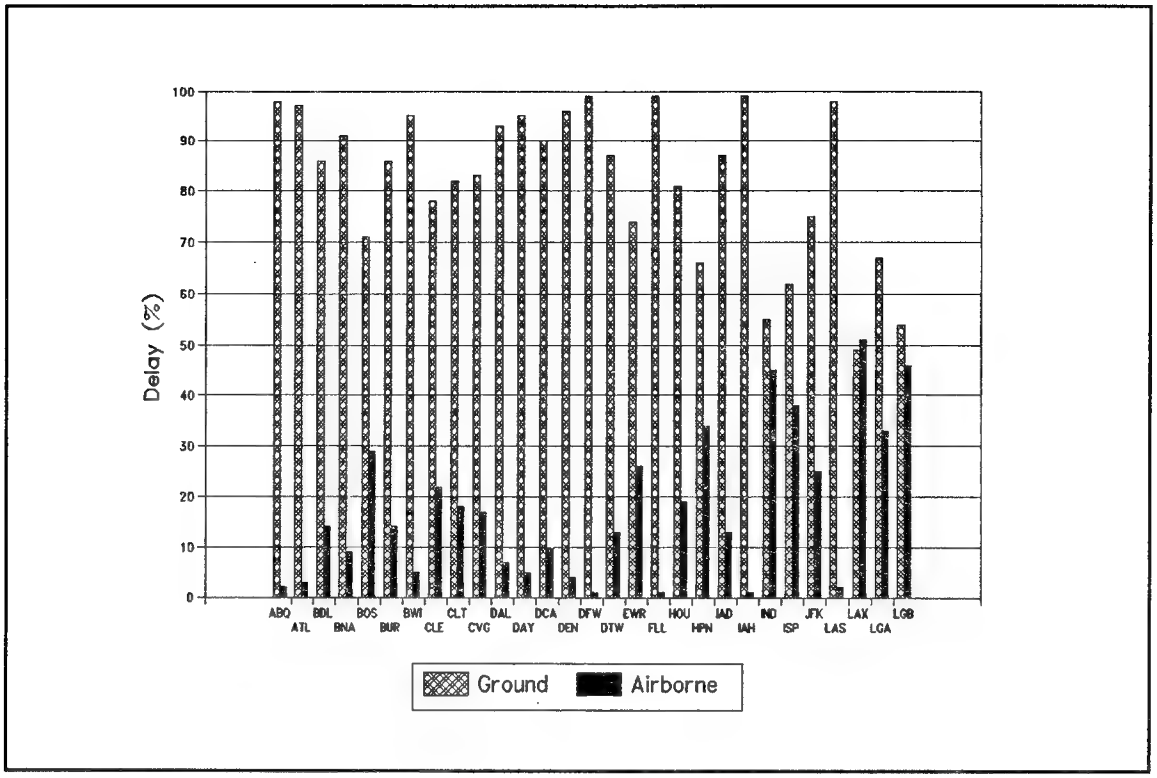

FIGURE 16. GROUND DELAY VS AIRBORNE DELAY YEAR 2005 (1 OF 2)

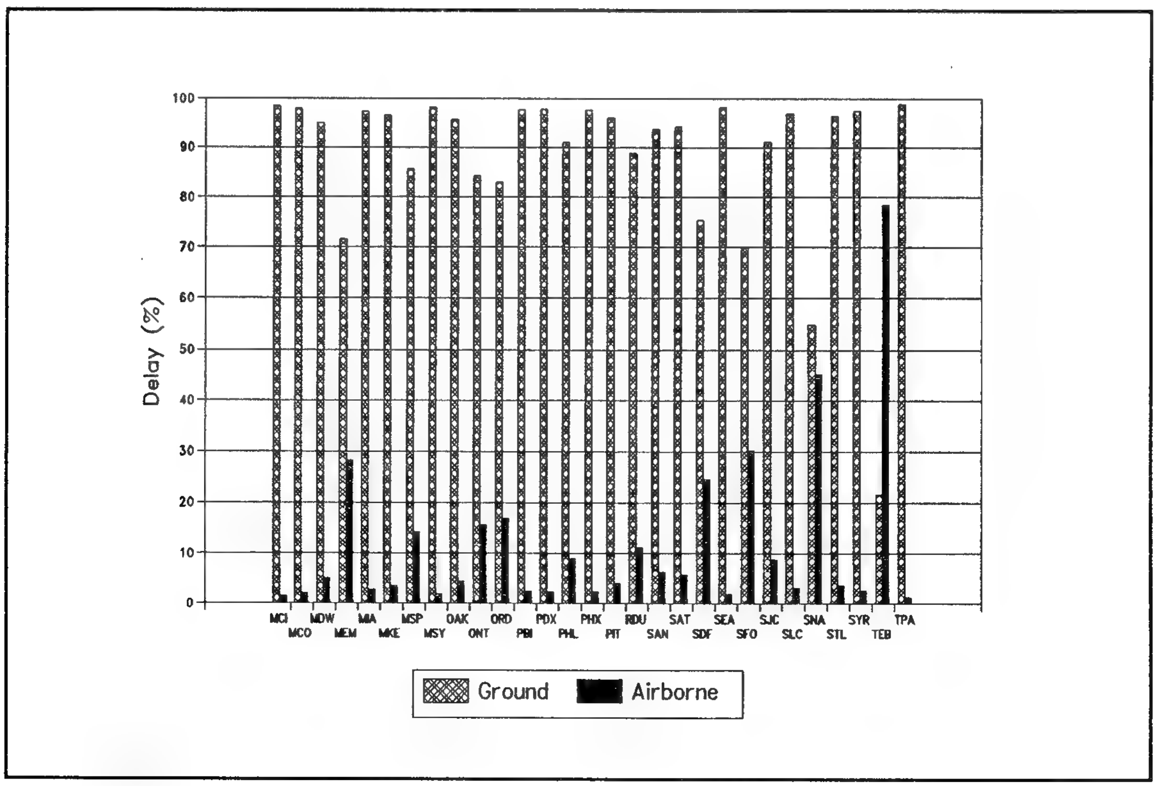

FIGURE 16. GROUND DELAY VS AIRBORNE DELAY YEAR 2005 (2 OF 2)

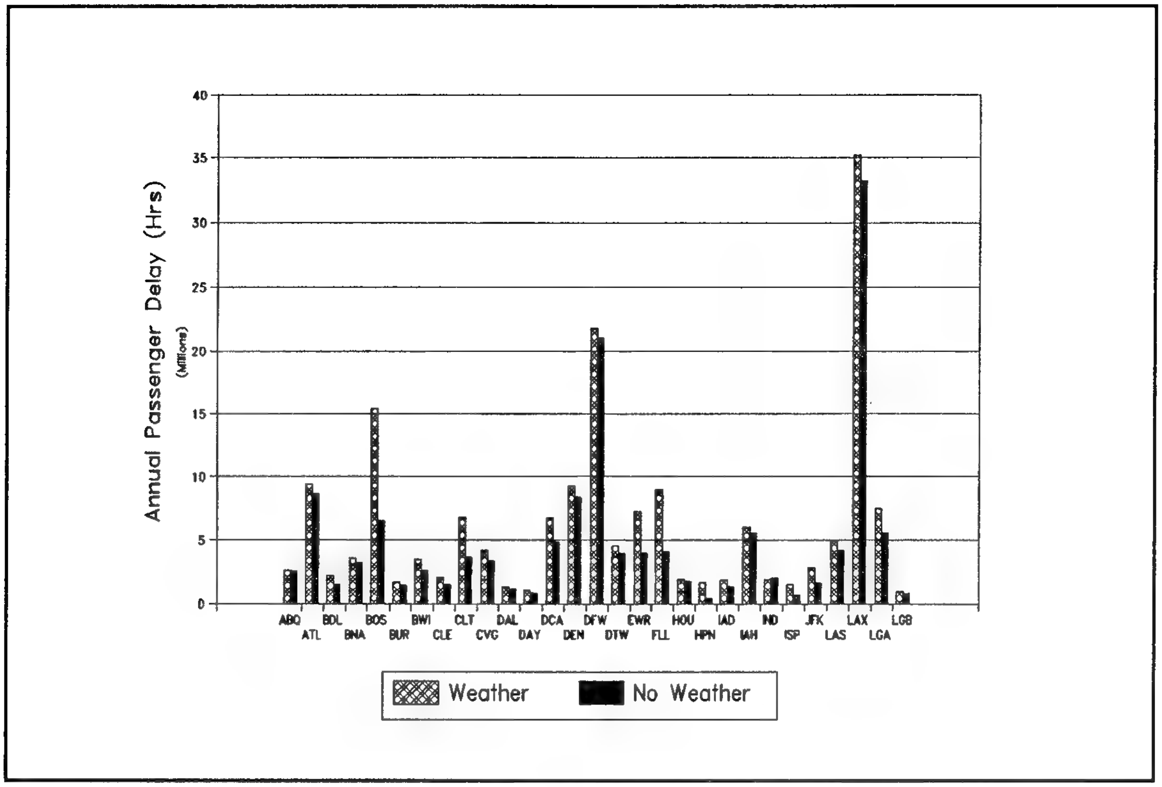

FIGURE 17. WEATHER RELATED DELAY OVER 15 MINUTES YEAR 2005 (1 OF 2)

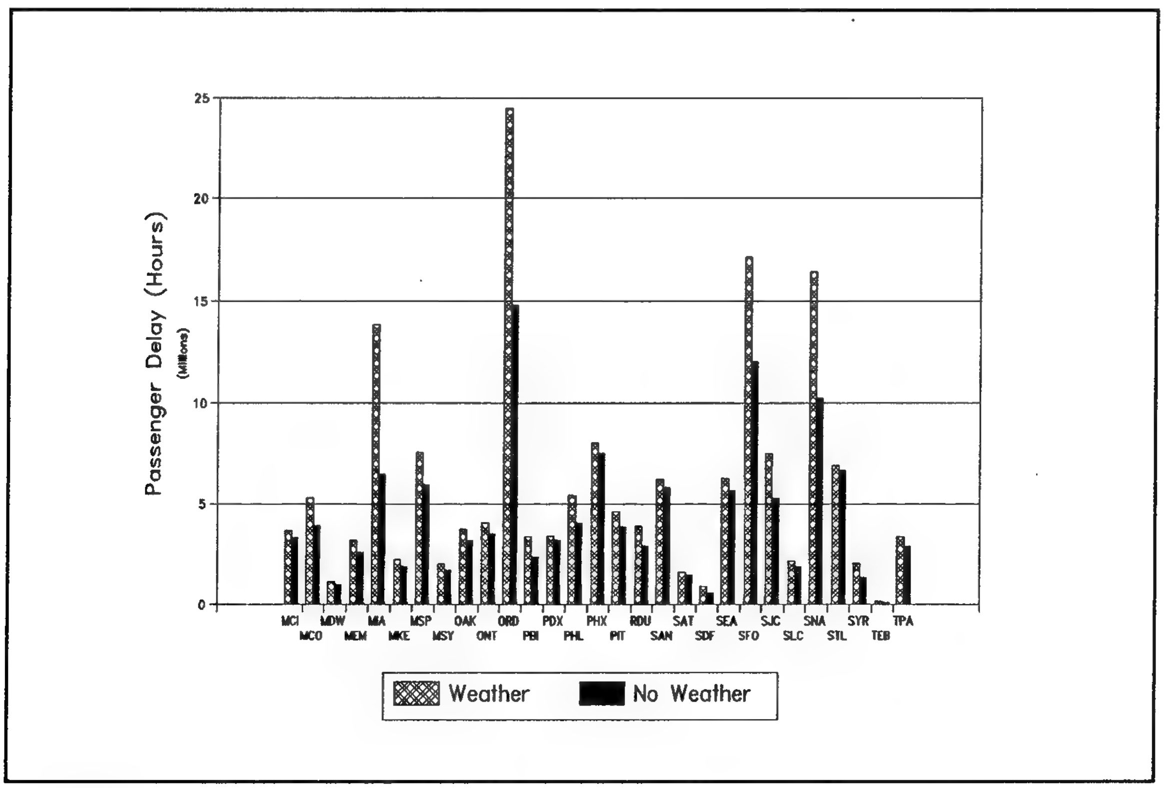

FIGURE 17. WEATHER RELATED DELAY OVER 15 MINUTES YEAR 2005 (2 OF 2)

5.3 AIRSPACE CONGESTION.

High traffic volume was observed at sectors ZBW020, ZBW047, ZDC019, ZID020, ZID022, ZID033, ZLA017, ZLA018, ZLA019, ZMA066, ZNY050, ZNY075, ZOA011, ZOA012, ZOA024, ZOA033, AND ZOB034 for the future system. As expected, the New York - Washington, Los Angeles - San Francisco, Chicago - Indianapolis, and Miami - Fort Lauderdale sectors show the most traffic and thus result in the highest delay at those airports contained in these areas. Sectors which show the most activity for year 2005 are displayed in figure 18.

5.4 VALIDITY ISSUES.

Simulation results from the 1990 scenario, that were used as a baseline for the annualization process, were compared to the statistics accumulated from Air Transport Association (ATA) findings recorded in the same year. The following table compares the two data sets as percent of delay by phase of flight:

	Airborne	Gatehold	Taxi-out	Taxi-in	% excess 15 min
ATA	29 %	6.8 %	48 %	16 %	10.3 %
NASPAC	22 %	9.0 %	52 %	17 %	12.1 %

The following table illustrates the cost comparisons of the two data sets in millions of dollars for year 1990:

	Airborne	Ground	Passenger	Totals
ATA	576	800	1000	3301
NASPAC	510	1100	1300	2910

6. CONCLUSIONS.

The analysis suggests that the majority of the future Air Traffic Control (ATC) system delay is caused by airfield capacity limitations. The analysis reveals that over three-fourths of the delay recorded in the model comes from ground related operations. This delay is due to either actual delay in ground operations or ground delay due to airborne holding. This would suggest that delay reductions will be achieved by implementing advanced ground-based systems designed to optimize runways and taxiway usage, as well as technology that is designed to optimize terminal airspace. Future investment strategies should focus on these types of technologies to increase system capacity.

Forty-five percent of the future system delay is caused by adverse weather. This would indicate that the future ATC system would not adequately accommodate the projected increase in traffic volume at major airports in the National Airspace System (NAS) without substantial delay. There are about a dozen airports in the NAS which contribute to the majority of the delay in the system. These airports are expected to exceed the number of arrivals and departures that the capacity of the airports can handle, without incurring delay, in year 2005.

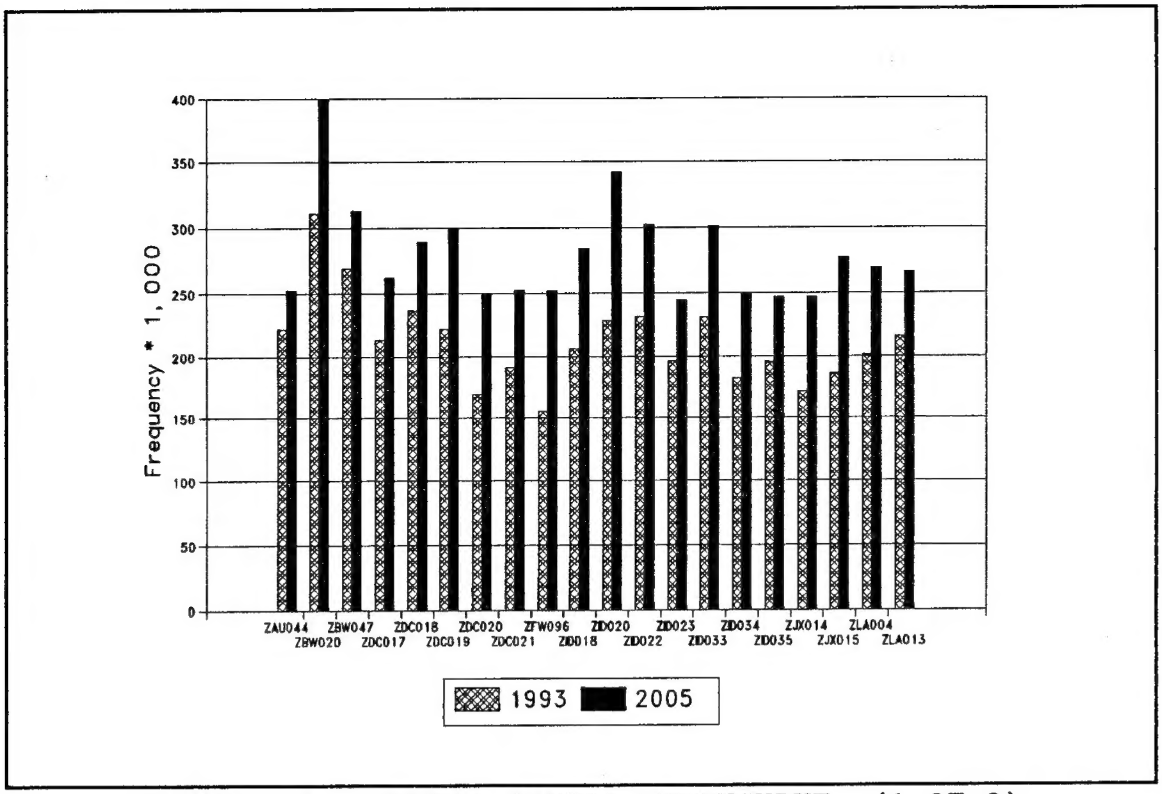

FIGURE 18. ANNUAL SECTOR THROUGHPUT (1 OF 2)

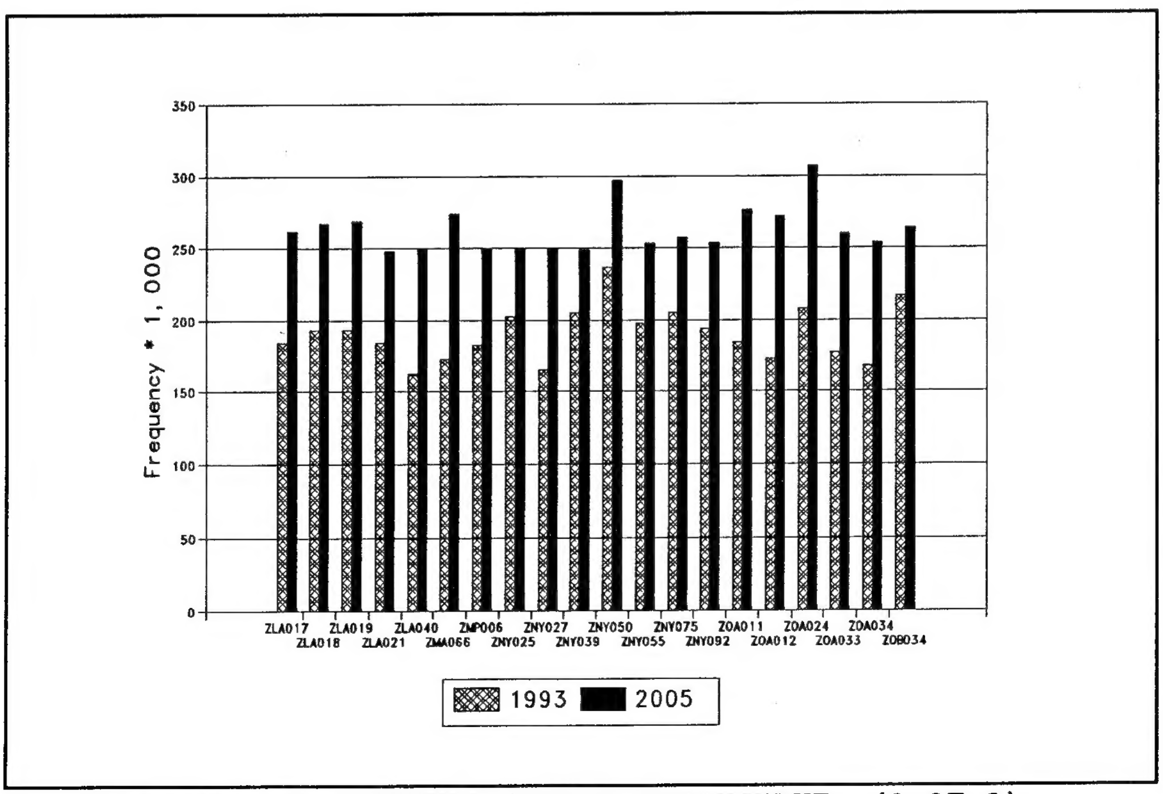

FIGURE 18. ANNUAL SECTOR THROUGHPUT (2 OF 2)

7. REFERENCES.

1.FAA/Office of Aviation Policy and Plans, Terminal Area Forecasts-Fiscal Year 1989-2005, Washington, DC, April 1992.

2.The MITRE Corporation, Summary of Methodology Used to Derive NASPAC Weather Annualization Scenario Days and to Determine Annual Results, the MITRE Corporation, McLean, Va, 23 July 1991.

APPENDIX A
AIRPORTS MODELED BY NASPAC

Airport ID	Airport Name	Airport ID	Airport Name
ABQ	Albuquerque	MCI	Kansas City
ATL	Atlanta	MCO	Orlando
BDL	Bradley	MDW	Chicago Midway
BNA	Nashville	MEM	Memphis
BOS	Boston	MIA	Miami
BUR	Burbank	MKE	Milwaukee
BWI	Baltimore/Washington	MSP	Minneapolis St. Paul
CLE	Cleveland	MSY	New Orleans
CLT	Charlotte	OAK	Oakland
CVG	Cincinnati	ONT	Ontario
DAL	Dallas Love	ORD	Chicago O'Hare
DAY	Dayton	PBI	West Palm Beach
DCA	Washington National	PDX	Portland
DEN	Denver	PHL	Philadelphia
DFW	Dallas/Fort Worth	PHX	Phoenix
DTW	Detroit	PIT	Pittsburgh
EWR	Newark	RDU	Raleigh Durham
FLL	Fort Lauderdale	SAN	San Diego
HOU	Houston	SAT	San Antonio
HPN	White Plains	SDF	Louisville
IAD	Washington Dulles	SEA	Seattle
IAH	Houston	SFO	San Francisco
IND	Indianapolis	SJC	San Jose
ISP	Islip	SLC	Salt Lake City
JFK	New York	SNA	Santa Ana
LAS	Las Vegas	STL	St. Louis
LAX	Los Angeles	SYR	Syracuse
LGA	La Guardia	TEB	Teterboro
LGB	Long Beach	TPA	Tampa

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